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Long-term ice loss from Greenland mediated by ice-load bedrock uplift feedback

Maria Zeitz[1,2], Jan Haacker[1,3], Jonathan Donges[1,4], and Ricarda Winkelmann[1,2]
[1]Potsdam Institute for Climate Impact Research, Potsdam, Germany
[2]Institute of Physics, Potsdam University, Potsdam, Germany
[3]Marine and Atmospheric Research, Utrecht University, Utrecht, Netherlands
[4]Stockholm Resilience Centre, Stockholm University, Stockholm, Sweden

Mass loss from the Greenland Ice Sheet has significantly accelerated over the past decades, both through enhanced melting as well as the acceleration of outlet glaciers. Positive feedback mechanisms, including the melt-elevation feedback and the ice-albedo feedback, introduce a non-linear evolution and may further accelerate mass loss. Negative feedbacks, such as the feedback between receding ice load and subsequent bedrock uplift, might counteract these accelerating positive feedbacks on long timescales. Bedrock uplift can amount to roughly one third of the change in the ice sheet thickness on a timescale of millennia. Here we explore the interplay of both positive and negative feedbacks, using simulations of the Greenland Ice Sheet with the Parallel Ice Sheet Model (PISM) including an Elastic Lithosphere Relaxing Asthenosphere (ELRA) model in an idealized warming scenario. In particular, we find that depending on the temperature anomaly (and thus the ice retreat rate) and the asthenosphere viscosity, distinct responses of the ice sheet are possible, ranging from the full or partial retreat of the ice sheet to the full or partial recovery of the ice sheet after an initial retreat, and potential large-scale self-sustained oscillations of ice volume on multi- millennial timescales.